EXAMINATION OF DRINKING WATER ON RAILWAY TRAINS

By Edward Bartow, Ph.D.

In order to determine the character of water furnished to the passengers on railway trains, 100 samples from water containers on trains have been collected and analyzed by members of the staff of the Illinois State Water Survey. Although the number of samples examined is small, the information obtained concerning the actual condition of the waters should be valuable in formulating practical standards. The samples were secured from trains at Champaign, Urbana, Kankakee and Chicago. It was thus possible to secure samples from cars coming from all parts of the country: from Boston, New York and other points in the East; Jacksonville, New Orleans and Galveston in the South; San Francisco, Los Angeles and Denver in the West; Minneapolis, Duluth, Sault St. Marie in the North. The water is usually a mixture from several sources. It was impossible to learn the points from which all the water had been taken, but with five exceptions the table indicates the points at which the tanks were last filled.

Of the 101 samples, 28 of the tanks were said to have been last filled at Chicago, 9 at Peoria, 8 at Centralia, 6 at Detroit, 5 at Cincinnati, 4 at Indianapolis, 3 at Kansas City, Missouri; 2 each at Memphis, Tennessee; Salamanca, New York; and New York City; 1 each at Boston, Massachusetts; Buffalo, New York; Champaign, Illinois; Dubuque, Iowa, Effingham, Illinois; Forrest, Illinois; Ft. Madison, Iowa; Ft. Wayne, Indiana; Grand Rapids, Michigan; Havana, Illinois; Lincoln, Nebraska; Mason City, Iowa; Mattoon, Illinois; Minneapolis, Minnesota; Montreal, Province of Quebec; Nashville, Tennessee; Parsons, Kansas; Pittsburgh, Pennsylvania; St. Louis, Missouri; St. Paul, Minnesota; Sioux City, Iowa; South Bend, Indiana; Springfield, Illinois; 4 were bottled water from Hammond, Louisiana, and 1 bottled water from Waukesha, Wisconsin, and unknown 5. The majority of samples, 57, were taken from coaches, 19 from sleepers, 8 from dining cars, 7 from smoking

cars, 6 from parlor cars, 2 from tourist sleepers, and of 3 there was no record.

The analyses include both bacteriological and chemical examinations and an attempt has been made to make them as complete as possible when using 120 cc. samples for bacterial examination and 1 liter samples for the chemical tests.

METHODS OF ANALYSIS

The analyses have been made as far as possible in accordance with Standard Methods of Water Analysis of the American Public Health Association (1912) and all analyses made after May 1 include confirmations of *B. coli*, made in accordance with the recommendations of the Commission on Standards for Common Carriers in Interstate Commerce.

For method of determining *Turbidity*, see Standard Methods, page 55. *Color*, Standard Methods, page 8. *Odor*, Standard Methods, page 8. *Residue*, Standard Methods, page 30; but before weighing the residue was heated in an oven for one hour at 180°. *Chlorine*, Standard Methods, page 42.

Magnesium. Neutralize 100 cc. of the water with $\frac{N}{50}$ sulphuric acid using methyl orange as indicator. Boil to expel carbon dioxide. Add 25 cc. of a saturated solution of lime water. Dilute to exactly 200 cc. with boiled distilled water. Cool and filter through a dry filter paper, rejecting the first 25 cc., titrate 50 cc. with $\frac{N}{50}$ sulphuric acid using methyl orange as indicator. Make a parallel determination using 100 cc. of pure distilled water. The number of cubic centimeters of $\frac{N}{50}$ acid required for the distilled water, minus the number of cubic centimeters of $\frac{N}{50}$ acid required for the sample times 9.6 equals parts per million of magnesium (Mg).

Alkalinity. Titrate 100 cc. of the water in a 200 cc. flask with $\frac{N}{50}$ sulphuric acid using first phenolphthalein and then methyl orange as indicators. The number of cubic centimeters of $\frac{N}{50}$ acid required times 10 equals parts per million of alkalinity in terms of $CaCO_3$.

Hardness. To the 100 cc. neutralized in determining alkalinity, add 10 cc. of soda reagent, a mixture of equal parts of approximately $\frac{N}{10}$ sodium hydroxide and $\frac{N}{10}$ sodium carbonate. Dilute with distilled water to exactly 200 cc. Allow to filter through dry filter paper rejecting the first 25 cc. and titrate 50 cc. of the filtrate with $\frac{N}{50}$ sulphuric acid to the methyl orange endpoint. Make a parallel

TABLE I

Analyses of water taken from railway trains

SAMPLE NO.	DATE OF COLLECTION	COLLECTOR	CITY	RAILROAD	TRAIN NO.	CAR	TANK FILLED AT	TURBIDITY	COLOR	ODOR	RESIDUE	CHLORINE	ALKALINITY	IRON	BACTERIAL COUNT Gelatin	BACTERIAL COUNT Agar	B. COLI IN LACTOSE BROTH SPECIAL 10 cc.
	1913																
1	Dec. 29	H.*	Champaign	I. C.	2	Diner	Hammond, La.	† 2	0	0	182	3	96	0.3	30,000	8,000	5–
2	Dec. 29	H.	Champaign	I. C.	2	Coach 28	Memphis	0	0	0	19	0	12	0.0	280	14	5–
3	Dec. 29	H.	Champaign	I. C.	2	Coach 3127	Centralia	1	0	0	344	23	92	0.0	187	5	3– 2+
4	Dec. 30	H.	Champaign	I. T. S.		Coach		1	0	0	18	0	10	0.0	125	18	5–
5	Dec. 30	H.	Champaign	Big 4	16	Coach 644	Peoria	3	0	0	80	27	20	0.0		13	3– 2+
6	Dec. 30	H.	Champaign	Wabash	36	Smoker	Champaign	8	20	0	426	0	356	0.6	10,000	1,500	5–
7	Dec. 31	H.	Champaign	I. C.	1	Diner	Hammond, La.	† 2	0	0	191	4	96	0.2	15,000	10,000	1– 4+
8	Dec. 31	H.	Champaign	I. C.	1	Sleeper	Chicago	15	20	0	147	1	94	0.4	1,500	510	2– 3+
9	Dec. 31	H.	Champaign	I. C.	1	Coach 2109	Chicago	10	5	0	159	3	96	0.0	54	23	5–
	1914																
10	Jan. 5	T.	Champaign	I. C.	1	Diner	Hammond, La.	† 2	0	0	205	10	100	0.3	1	4	5–
11	Jan. 5	T.	Champaign	I. C.	1	Coach	Chicago	5	0	0	357	50	76	0.0	600	61	2– 3+
12	Jan. 5	T.	Champaign	I. C.	1	Coach	Chicago	20	5	0	170	3	108	0.1	90	36	2– 3+
13	Jan. 5	T.	Champaign	I. C.	24	Smoker	Centralia	3	0	0	148	32	28	0.0	20	15	4– 1+
14	Jan. 5	T.	Champaign	I. C.	24	Coach	Centralia	0	0	0	42	2	26	0.0	160	75	5–
15	Jan. 5	T.	Champaign	I. C.	24	Coach	Effingham	0	0	0	150	12	84	0.0	61	24	5–
16	Jan. 5	H.	Kankakee	C. I. & S.		Coach	South Bend, Ind.	0	0	0	331	10	216	0.0	140	30	5–
17	Jan. 7	T.	Champaign	Big 4	16	Coach	Peoria	7	3	0	526	22	268	2.5	36	14	5–
18	Jan. 7	T.	Champaign	Big 4	16	Coach	Peoria	7	0	0	524	2	260	0.0	52	19	4– 1+
19	Jan. 12	M.	Chicago	I. C.	18	Buffet	Springfield	5	5	0	43	8	8	2.0	60	13	5–
20	Jan. 12	M.	Chicago	I. C.	18	Sleeper	Parsons, Kan.	0	0	0	29	3	12	0.0	140	200	5–
21	Jan. 12	M.	Chicago	Big 4	31	Parlor car	Cincinnati, O.	5	0	0	25	2	10	0.05	10,000	2,500	5+
22	Jan. 12	M.	Chicago	Big 4	31	Sleeper	Cincinnati, O.	0	0	0	163	6	36	0.0	300	220	5–
23	Jan. 12	M.	Chicago	Big 4	43	Coach	Cincinnati, O.	2	0	0	102	9	24	0.05	50	10	4– 1+
24	Jan. 12	M.	Chicago	Big 4	43	Sleeper	Cincinnati, O.	12	0	0	91	15	36	0.0	400	54	4– 1+
25	Jan. 12	M.	Chicago	Soo	2	Diner	Waukesha, Wis.†								3,500	300	5–

26	Jan. 19	S.	Chicago	C. & E. I.	21	Car 492		3	0	0	161	24	62	0.1	1,100	69	2- 3+
27	Jan. 19	S.	Chicago	Santa Fe	9	Tourist	Chicago								790	40	4- 1+
28	Jan. 19	S.	Chicago	Santa Fe	9	Diner	Chicago	2	0	0	458	16	278	0.2	18	3	5-
29	Jan. 19	S.	Chicago	Santa Fe	6	Smoker	Ft. Madison	5	0	0	95	4	38	0.0	6,000	46	5-
30	Jan. 19	S.	Chicago	C. & E. I.	9	Car 432	Chicago	20	5	0	125	4	86	0.2	1,000	130	3- 2+
31	Jan. 19	S.	Chicago	C. & E. I.	6	Car 976	Nashville, T.	0	0	0	85	4	46	0.0	50,000	6	5-
32	Jan. 19	S.	Chicago	Erie	47	Sleeper	Salamanca, N. Y.	20	5	0	114	4	78	0.6	500	24	4- 1+
33	Jan. 19	S.	Chicago	Erie	47	Car 1037	Salamanca, N. Y.	2	10	0	37	4	14	0.1	23	4	5-
34	Jan. 19	S.	Chicago	Wabash	50	Car 1082	Forest, Ill.	25	35	0	48	4	16	1.9	5,000	20	5-
35	Jan. 19	S.	Chicago	Wabash	7	Sleeper	Montreal	20	20	0	123	6	76	0.0	710	100	5-

* Collections have been made by W. W. Hanford (H), F. W. Tanner (T), F. W. Mohlman (M), and C. H. Spaulding (S).

† Denotes bottled water.

TABLE II

Analyses of water taken from railway trains

SAMPLE NO.	DATE OF COLLECTION	COLLECTOR	CITY	RAILROAD	TRAIN NO.	CAR	TANK FILLED AT	TURBIDITY	COLOR	ODOR	RESIDUE	CHLORINE	MAGNESIUM	ALKALINITY $CaCO_3$		HARDNESS $CaCO_3$	SULPHATE	IRON	COPPER AND LEAD	BACTERIAL COUNT		B. COLI GAS FORMATION 10 cc.	
														Ph.	M. O.					Gelatin	Agar	L. B.	Conf.
	1914																						
36	May 6	M.*	Chicago	M. C.	7	Sleeper	Grand Rapids	10	5	0	170	5	8.6	4.0	72	112	35.0	0.0	0.0	300	200	5−	5−
37	May 6	M.	Chicago	M. C.	7	Sleeper	Detroit	8	10	0	118	7	4.8		54	48	13.6	0.2	0.1	9	10	3− 2+	3− 2+
38	May 6	M.	Chicago	Big 4	31	Sleeper	Cincinnati	2	0	0	28	0	0.0		7	8	0.0	0.4	0.05	850	600	5−	5−
39	May 6	M.	Chicago	I. C.	10	Sleeper	Memphis	5	0	0	113	4	4.8		76	72	4.9	0.0	10.5	700	1000	2− 3+	5−
40	May 6	M.	Chicago	I. C.	12	Sleeper	Sioux City, Ia.	15	5	0	298	6	18.2		188	196	34.7	0.2	0.05	50,000	125	4− 1+	5−
41	May 6	M.	Chicago	Big 4	3	Diner	Buffalo	10	10	0	165	4	3.8		100	88	11.9	0.15	0.0	950	35	1− 4+	1− 4+
42	May 6	M.	Chicago	I. C.	30	Sleeper	St. Paul	0	0	0	31	0	0.0		5	4	0.0	0.1	0.0	10,000	1,800	5−	5−
43	May 6	M.	Chicago	M. C.	13	Sleeper	Detroit	2	3	0	27	0	0.0		10	4	0.0	0.4	0.0	400	200	3− 2+	3− 2+
44	May 6	M.	Chicago	M. C.	13	Tourist	Boston	2	0	0	20	0	0.0		5	8	0.0	0.5	0.0	30	5	5−	5−
45	May 6	M.	Chicago	I. C.	28	Parlor car	Dubuque, Ia.	2	0	0	123	5	9.6		86	76	8.6	0.1	0.0	550	375	5−	5−
46	May 6	T.*	Champaign	I. C.	1	Car 3131	Chicago	5	0	0	44	1	1.9		20	12	0.0	0.05	0.0	850	320	5+	2− 3+
47	May 13	T.	Champaign	I. C.	24	Car 3106	Centralia	2	0	0	31	0	1.0		8	4	0.0	0.0	0.0	20	14	5−	5−
48	May 13	T.	Champaign	I. C.	24	Car 3777	Centralia	2	0	0	48	1	2.9		20	12	3.7	0.0	0.0	35	20	5−	5−
49	May 13	T.	Champaign	I. C.	1	Car 2514	Chicago	3	0	0	32	0	4.8		14	8	0.0	0.05	0.1	1,350	900	1− 4+	1− 4+
50	May 13	T.	Champaign	I. C.	1	Car 3182	Chicago	3	0	0	130	1	5.8		34	32	43.6	0.0	0.0	10	4	3− 2+	3− 2+
51	May 13	T.	Champaign	I. C.	24	Car 2504	Centralia	2	0	0	38	0	1.0		14	12	3.3	0.0	0.0	80	10	5−	5−
52	May 18	T.	Champaign	Big 4	16	Car 655		2	0	0	85	19	0.0		50	32	0.0	0.2	0.0	10,000	3,000	3− 2+	3− 2+
53	May 18	T.	Champaign	Big 4	16	Coach 729		3	0	0	55	3	8.8		16	24	trace	0.0	0.1	27,000	3,000	5−	5−
54	May 18	T.	Champaign	Big 4	16	Smoker 657	Peoria	10	0	0	330	30	21.6		170	244	55.1	0.15	0.2	500	800	5+	5+
55	May 18	T.	Champaign	Big 4	16	Coach 717	Peoria	10	0	0	260	20	15.4		136	176	45.3	0.15	0.0		1,200	5+	1− 4+
56	May 24	T.	Champaign	I. C.	1	Car 3131	Chicago	2	0	0	60	2	6.7		38	28	trace	0.0	0.0	860	500	5−	5−
57	May 24	T.	Champaign	I. C.	23	Car 3102	Chicago													90	25	5−	5−
58	May 24	T.	Champaign	I. C.	1	Car 2901	Chicago	1	0	0	48	2	2.9		20	16	trace	0.0	0.0	850	400	5−	5−
59	May 24	T.	Champaign	I. C.	23	Car 3162	Chicago	1	0	0	118	2	7.7		62	28	21.2	0.0	0.0	75	25	5−	5−
60	May 28	T.	Champaign	I. C.	1	Coach	Chicago	2	0	0	110	12	6.7		36	48	79.4	0.0	0.0	1,200	350	5−	5−
61	May 28	T.	Champaign	I. C.	23	Smoker	Chicago	2	0	0	34	3	2.9		14	12	28.0	0.0	0.0	30	3	5−	5−
62	May 28	T.	Champaign	I. C.	1	Coach	Chicago	2	0	0	570	42	22.1		139	260	256.0	0.1	0.1	4,000	130	4− 1+	4− 1+
63	May 28	T.	Champaign	I. C.	23	Coach	Chicago	2	0	0	163	5	15.4		103	140	49.0	0.15	0.0	20,000	210	4− 1+	4− 1+
64	June 1	T.	Champaign	Big 4	9	Coach 694	Indianapolis, Ind.	20	5	0	502	24	28.8		280	420	130.0	0.5	0.3	600	350	4− 1+	4− 1+
65	June 1	T.	Champaign	Big 4	9	Coach 655	Peoria	2	0	0	253	14	15.4		143	224	68.7	0.25	0.0	6,000	1,800	5−	5−
66	June 1	T.	Champaign	Big 4	9	Coach 944	Indianapolis, Ind.	2	0	0	467	25	25.9		263	424	123.8	0.4	0.1	180	90	1− 4+	1− 4+
67	June 1	T.	Champaign	Big 4	16	Coach 697	Peoria	2	0	0	202	23	15.4		95	128	40.3	0.2	0.0	160	20	5−	5−

	1914																						
68	June 10	T.	Champaign	Big 4	16	Coach 655	Peoria	0	0	0	286	38	11.5		130	120	42.8	0.0	0.0	12,000	8,000	5+	5+
69	June 10	T.	Champaign	Big 4	9	Coach 944	Indianapolis, Ind.	0	20	0	441	21	4.8		248	220	88.4	0.8	0.0	20,000	11,000	5+	5+
70	June 10	T.	Champaign	Big 4	16	Coach 697	Peoria	0	0	0	219	11	3.8		112	104	48.1	0.1	0.0	25,000	15,000	4— 1+	4— 1+
71	June 10	T.	Champaign	Big 4	9	Coach 743	Indianapolis, Ind.	0	5	0	369	20	17.3		234	200	76.5	0.1	0.0	30,000	10,000	5+	5+
72	June 11	T.	Champaign	I. C.	622	Coach 1579	Havana, Ill.	0	3	0	25	3	5.8		10	44	6.2	1.4	0.0	160	40	5—	5—
73	June 11	T.	Champaign	I. C.	1	Coach 2507	Chicago	0	0	0	173	3	2.9		93	44	13.6	0.1	0.0	1,350	800	5+	1— 4+
74	June 11	T.	Champaign	I. C.	1	Coach 2514	Chicago	0	0	0	127	2	2.9		94	36	8.2	0.0	0.0	1,800	1,000	5+	5+
75	June 19	B.*	Chicago	C. B. & Q.	2	Coach	Lincoln, Ill.	2	0	0	293	18	11.5		162	112	57.2	0.4	0.0	7,000	2,250	3— 2+	3— 2+
76	June 19	B.	Chicago	C. B. & Q.	58	Sleeper	Minneapolis, Minn.	2	0	0	146	3	6.7		45	36	30.9	0.6	0.0	30	3,600	5—	5—
77	June 19	B.	Chicago	Penn.	15	Coach	Ft. Wayne, Ind.	0	0	0	162	16	2.9		26	56	65.0	0.6	0.0	15	1,350	5+	5+
78	June 19	B.	Chicago	C. & A.	10	Smoker	Kansas City, Mo.	30	15	3m	268	12	4.8		88	104	83.9	0.0	0.0	80,000	30,000	5+	5+
79	June 19	B.	Chicago	C. M. & St. P.	2	Coach	Mason City, Ia.	0	0	0	170	17	10.6		66	92	40.3	0.0	0.0	5,500	1,500	3— 2+	3— 2+
80	June 18	B.†	Chicago	C. & A.	8	Coach	St. Louis	0	0	0	169	2	12.5		116	116	none	0.0	0.0	10,000	180	5+	1+ 4—
81	June 19	B.	Chicago	Penn.	25	Sleeper	Pittsburgh	0	0	0	145	4	12.5		116	96	none	0.0	0.0	220	35	3— 2+	5—
82	June 19	B.	Chicago	C. B. & Q.	56	Sleeper	Kansas City, Mo.	0	0	0	185	7	12.5		64	76	69.1	0.0	0.0	340	450	3— 2+	3— 2+
83	June 19	B.	Chicago	C. M. & St. P.	12	Sleeper	Kansas City, Mo.	5	0	0	142	6	5.8		50	48	42.8	0.0	0.0	900	2,250	3— 2+	3— 2+
84	June 19	B.	Chicago	Penn.		Parlor car	Chicago	10	0	0	158	5	9.6		114	76	20.6	0.0	0.0	10,000	5,400	3— 2+	3— 2+
85	June 25	C.*	Chicago	M. C.	17	Sleeper	Detroit	2	0	0	128	4	10.6		64	48	trace	0.0	0.0	1,350	230	5—	5—
86	June 25	C.	Chicago	M. C.	17	Sleeper	Detroit	2	0	0	23	10	6.7		18	8	trace	0.0	0.0	2,900	1,260	5—	5—
87	June 25	C.	Chicago	M. C.	17	Parlor car	Detroit	2	0	0	58	3	10.6		36	32	trace	0.0	0.0	5,000	510	3— 2+	5—
88	June 25	C.	Chicago	M. C.	13	Coach	Detroit	2	0	0	166	25	18.2		96	48	trace	0.0	0.0	9,000	520	5—	5—
89	June 25	C.	Chicago	M. C.	13	Sleeper	New York	2	0	0	48	3	5.8		22	8	trace	0.0	0.0	1,560	640	3— 2+	4— 1+
90	June 25	C.	Chicago	M. C.	13	Sleeper	New York	3	20	0	120	5	15.4		58	72	trace	0.0	0.0	220	91	3— 2+	5—
91	June 25	C.	Chicago	I. C.	24	Parlor car	Mattoon	5	15	0	302	12	33.6		252	144	trace	trace	0.0	8,100	6,600	4— 1+	4— 1+
92	June 25	C.	Chicago	I. C.	24	Coach	Mattoon	1	0	0	44	2	8.6		16	4	trace	0.0	0.0	260	183	5—	5—
93	Dec. 30	H.*	Champaign	I. C.	23	Smoker	Chicago	2	3	0	24	6	4.8		21	16	0.0	0.1	0.0	10,000	17	5—	5—
94	Dec. 30	H.	Champaign	I. C.	24	Coach 2166	Centralia	2	0	0	124	5	12.5		95	76	0.0	0.1	0.0	25	2	5—	5—
95	Dec. 30	T.*	Champaign	I. C.	1	Coach 3107	Chicago	2	0	0	426	35	19.2		124	192	16.7	0.2	0.0	13	33	5—	5—
96	Dec. 30	H.*	Champaign	I. C.	24	Coach 2127	Centralia	2	2	0	28	6	0.0		21	0	0.0	0.3	0.0	14	4	5—	5—
97	Dec. 30	T.*	Champaign	I. C.	1	Coach 2507	Chicago	0	0	0	81	8	6.7		35	32	trace	0 5	0.0	3,000	120	4— 1+	5—
98	Dec. 30	T.	Champaign	I. C.	1	Coach 2515	Chicago	0	2	0	132	16	10.5		42	54	4.8	0.1	0.0	1,200	14	5—	5—
99	Dec. 30	H.*	Champaign	I. C.	1	Diner	Hammond, La.†	0	2	0	179	7	21.1		100	un-det.	0.0	0.3	0.0	250	110	5+	5+
100	Dec. 31	T.*	Champaign	I. C.	1	Coach 2117	Chicago	3	0	0	60	5	4.8		32	un-det.	0.0	0.0	0.0	5	6	5—	5—
101	Dec. 31	H.*	Champaign	I. C.	1	Parlor car	Chicago	25	0	0	175	6	6.7		114	80	0.0	1.6	0.0	1	10	5—	5—
102	June 25	C.*	Chicago	I. C.	25	Coach	Chicago	1	0	0	27	3	0.0		6	0	trace	0.0	0.0	580	260	4— 1+	5—

* Collections were made by F. W. Mohlman (M), F. W. Tanner (T), A. N. Bennett (B), H. P. Corson (C), W. W. Hanford (H).

† Denotes bottled water.

determination using 100 cc. of distilled water. The number of cubic centimeters of $\frac{N}{50}$ acid used for the distilled water less the number of cubic centimeters $\frac{N}{50}$ acid used for the sample times 40 equals the number of parts per million of hardness as $CaCO_3$. When the alkalinity exceeds the hardness, carbonates or bicarbonates of sodium or potassium are indicated.

Iron. Standard Methods, page 45.

Lead and copper. Use 100 cc. of water, add 2 grams pure crystals of ammonium chloride, 2 cc. acetic acid and 2 to 3 drops of 10 per cent sodium sulphide (Na_2S) solution. Compare immediately with standards containing known amounts of lead nitrate. The standards should contain 0.01, 0.02, 0.03 mg. of Pb.

Number of bacteria per cubic centimeter. The total number of bacteria developing on gelatin incubated 48 hours at 20°C. Standard Methods, 1905, page 82. Total number of bacteria developing on standard agar plates incubated for 24 hours at 37°C. See *Public Health Reports,* November 6, 1914, page 2960.

B. coli. See *Public Health Reports,* November 6, 1914, page 2960.

Ninety-nine samples were examined for turbidity. Of these 70 showed a turbidity less than 5 parts per million; 82 less than 10; 89 less than 15; and only 10 showed 15 or more. A turbidity below 10 would not make the water appear unattractive and it would seem not unreasonable to require a standard of 10 or less.

Ninety-nine samples were examined for color. Seventy-nine of the samples had a color less than 5 parts per million; 88 less than 10; 93 less than 20; and only 6 had 20 or more. A color requirement of 20 or less should be easy to meet and it would not be impossible to meet a requirement of 10 or less.

Ninety-nine samples were examined for residue. Of these 28 had a residue less than 50 parts per million; 36 less than 100; 75 less than 200; 84 less than 300; 90 less than 400; 95 less than 500; and only 4 above 500. The very low residues are undoubtedly due to the presence of melted ice in the coolers. The few samples containing more than 500 parts per million would indicate that a standard of 500 or less could easily be made.

Chlorine was determined in 99 samples. Of these 46 had less than 5 parts per million; 66 had less than 10; 75 had less than 15; 82 had less than 20; 90 had less than 25, and only 9 more than 25 parts per million. It should not be difficult to obtain a water containing less than 15 parts of chlorine per million and it should certainly be easy to obtain water containing less than 25 parts per

million. In special cases where it is not possible to obtain waters with low mineral content, exceptions to the rule may be made. The same may be true also of residue, magnesium sulphates, alkalinity and hardness.

Sixty-six were examined for magnesium. Of these 39 contained less than 10 parts per million; 51 less than 15; 60 less than 20, and only 6 more than 20 parts per million. In the large majority of cases, therefore, it should be easy to obtain waters containing less than 20 parts per million of magnesium. If the magnesium were all present as sulphate, 20 parts of magnesium would be equal to 100 parts of magnesium sulphate.

The alkalinity using phenolphthalein and methyl orange as indicators was determined in 99 samples. In only one case was a water found which was alkaline to phenolphthalein. A requirement that the alkalinity to phenolphthalein shall not be greater than one-half the alkalinity to methyl orange would be easy to fulfill and would guard against the use of water over-treated with lime. Forty-three samples contained less than 50 parts of alkalinity to methyl orange, 71 less than 100, 89 less than 200. Only 10 had an alkalinity of over 200, and only one of more than 300. A standard of 300 or less would be very easy to maintain and a standard of 200 or less would not be impossible.

The total hardness was determined on 64 samples. Of these 34 had a total hardness of less than 50; 45 less than 100; 57 less than 200. Only 7 had a hardness of more than 200 and but 2 a hardness of more than 300. A limit of 300 would be very easy to maintain and it should not be difficult to obtain waters containing less than 200.

Sixty-six waters were examined for sulphates. Thirty-six waters contained less than 10 parts per million of SO_4; 42 less than 25; 54 less than 50; 63 less than 100, and only 3 more than 100. It should be apparently very easy to furnish waters having less than 100 parts per million of sulphates.

Ninety-nine samples were examined for iron. Eighty-six of these contained less than 0.5 parts per million of Fe; 94 less than 1.0; and only 5 had more than two parts per million. A standard of less than one part per million would be very easy to maintain and it would not be unreasonable to ask for less than 0.5 parts.

Sixty-six samples were examined for lead and copper. Fifty-six of these showed no trace of either metal; 7 contained 0.1 part per million; 2 contained 0.2, and 1 contained 0.3. It would not seem difficult to maintain a standard of less than 0.3 part per million.

One hundred samples were plated on gelatin and the number of colonies counted at the end of 48 hours. Of these, 29 samples had less than 99; 16 samples from 100 to 499; 16 from 500 to 999; 9 from 1000 to 1999; 9 from 2000 to 9999; and 21 more than 10,000.

One hundred and two samples were plated on agar and incubated at 37.5°C. for 24 hours. Forty samples showed less than 50 bacteria per cubic centimeter; 7 from 50 to 99; 8 from 100 to 199; 14 from 200 to 499; 8 from 500 to 999; 10 from 1000 to 1999; 10 from 2000 to 9999; and 5 had more than 10,000.

While the large number of bacteria may consist for the most part of harmless forms, the results would indicate unsatisfactory conditions, either in the original water taken or in the conditions of storage and delivery.

The Commission on Standards have made no recommendation concerning the use of gelatin but their standard of less than 100 growing on agar would mean that 53 per cent of the waters examined were unsatisfactory.

One hundred and nine positive tests for gas formation were obtained in 67 samples examined after May 1. Ninety-one, or 83 per cent, of these were shown by the confirmatory tests to contain *B. coli*.

Twenty of the 67 waters were shown to be unsatisfactory by both the standard for *B. coli* and agar count of the Commission on Standards of Purity for Common Carriers. Four more did not conform to the *B. coli* standard alone and 24 more did not conform to the agar count standard, making a total of 49 of 67 samples or 73 per cent which did not conform to the standards set by the Commission.

While our methods differ from Creel (*Hygienic Laboratory Bulletin 100*, 43–57) the results judged by the *B. coli* standard are similar, showing that a better water is found on sleeping cars and parlor cars and the poorer water is found on coaches and smoking cars.

Mr. W. W. Hanford of the Illinois State Water Survey is making a study of the character of the water supplied to railway trains from points in Illinois. As time permits we expect to make more analyses of samples of water taken from trains. An improvement is to be expected as the railway officials are endeavoring to improve conditions as rapidly as possible.

Credit must be given to the members of the laboratory staff of the Illinois State Water Survey for the work which is described in this article.